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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ROYAL IRRIGATION DEPARTMENT  
MINISTRY OF AGRICULTURE AND COOPERATIVES  
THE KINGDOM OF THAILAND

**THE STUDY  
ON  
THE KOK-ING-NAN WATER DIVERSION PROJECT  
IN  
THE KINGDOM OF THAILAND**

**FINAL REPORT**

**(Summary Report of  
Environmental Technical Assistance Study)**

NOVEMBER 1999

SANYU CONSULTANTS INC.  
NIPPON KOEI CO., LTD.



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## PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a study on the Kok-Ing-Nan Water Diversion Project (Phase II) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Shoichiro Higuchi of SANYU CONSULTANTS INC. and consisted of SANYU CONSULTANTS INC. and NIPPON KOEI Co., Ltd. to Thailand, 3 times between December, 1997 and October, 1999. In addition, JICA set up an advisory committee headed by Mr. Hidetomi Oi, Development Specialist, JICA between December, 1997 and October, 1999, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Thailand and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Thailand for their close cooperation extended to the Team.

November 1999



Kimio Fujita  
President

Japan International Cooperation Agency



November 24, 1999

Mr. Kimio Fujita  
President,  
Japan International Cooperation Agency  
Tokyo, Japan

**Letter of Transmittal**

Dear Mr. Fujita,


We are pleased to submit hereby the Final Report on the Feasibility Study and the Environmental Technical Assistance Study on the Kok-Ing-Nan Water Diversion Project (Phase II Study) in the Kingdom of Thailand. This report incorporates advice and suggestions of authorities concerned of the Government of Japan and your good agency as well as the comments made by the Royal Irrigation Department (RID) of the Ministry of Agriculture and Cooperatives and other responsible agencies of the Government of Thailand on the formulation of the project during technical discussions on the draft final report, which were held in Tokyo and Bangkok.

In the light of urgent importance of solving water shortage problems prevailing over the Chao Phraya basin, the Study is to supplement and strengthen the study initiated already by the Government of Thailand. Following the Conceptual Planning Study and the IEE as the Phase I Study, the Phase II Study was formulated and evaluated from both engineering and economic point of view for further implementation of the Project. The Environmental Technical Assistance Study was also conducted focusing mainly on the review of the EIA made by the Thai-side inclusive of some supplemental studies in the field of watershed management, etc.

In view of critical condition of balance between demand and supply of water and of need for sustainable development of the Chao Phraya basin as a whole, water diversion as studied can be considered as one of the effective measures. The Study aims to furnish full information regarding the demand and supply of water so that the Government of Thailand can make decision for further implementation of the Project under due consideration of not only technical aspects but also economic and other situation of the country. The magnitude of influence that might be caused by Project would also be considerable, and therefore public relation activities should be executed not only in the Kok, Ing and upper Nan basins but also in the direct beneficiary areas in the lower Nan and Chao Phraya delta.

We wish to take this opportunity to express our heartfelt gratitude to your Agency and other authority concerned of the Government of Japan as well as to the RID and other agencies of the Government of Thailand for close cooperation and assistance extended to us during the course of our investigations and studies.

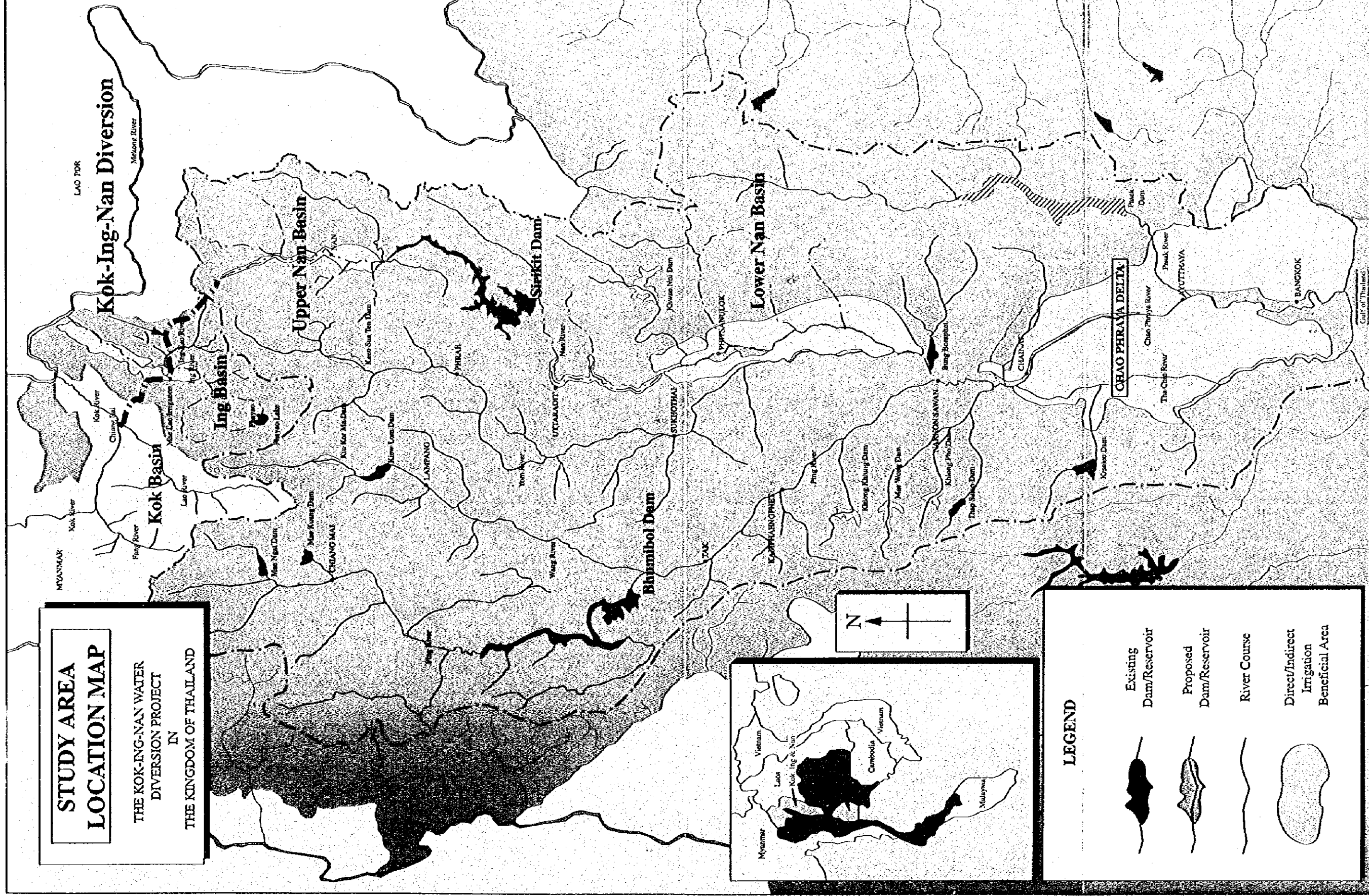
Very truly yours,



Shoichiro Higuchi  
Leader of the Study Team

# STUDY AREA LOCATION MAP

THE KOK-ING-NAN WATER  
DIVERSION PROJECT  
IN  
THE KINGDOM OF THAILAND



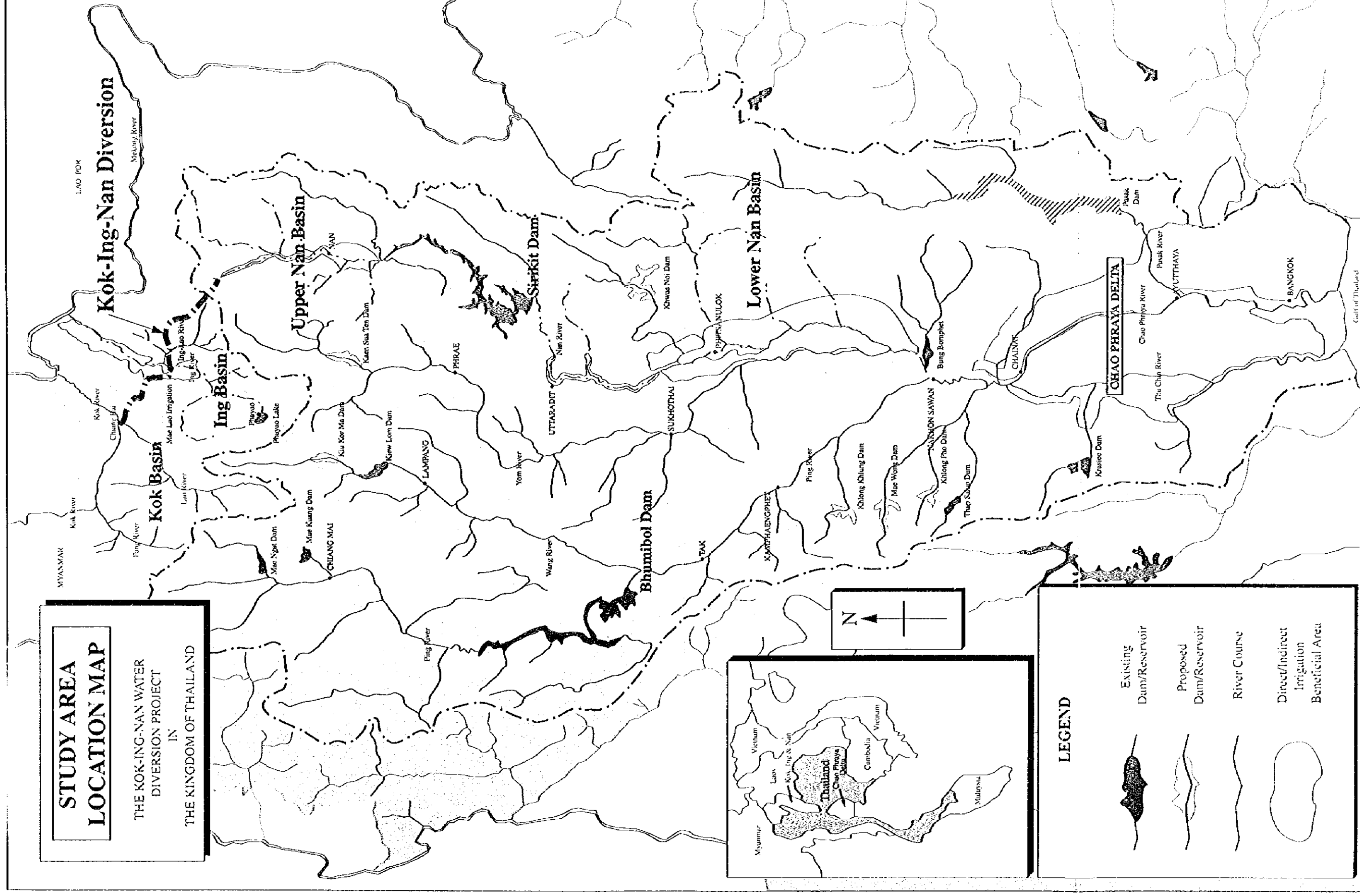
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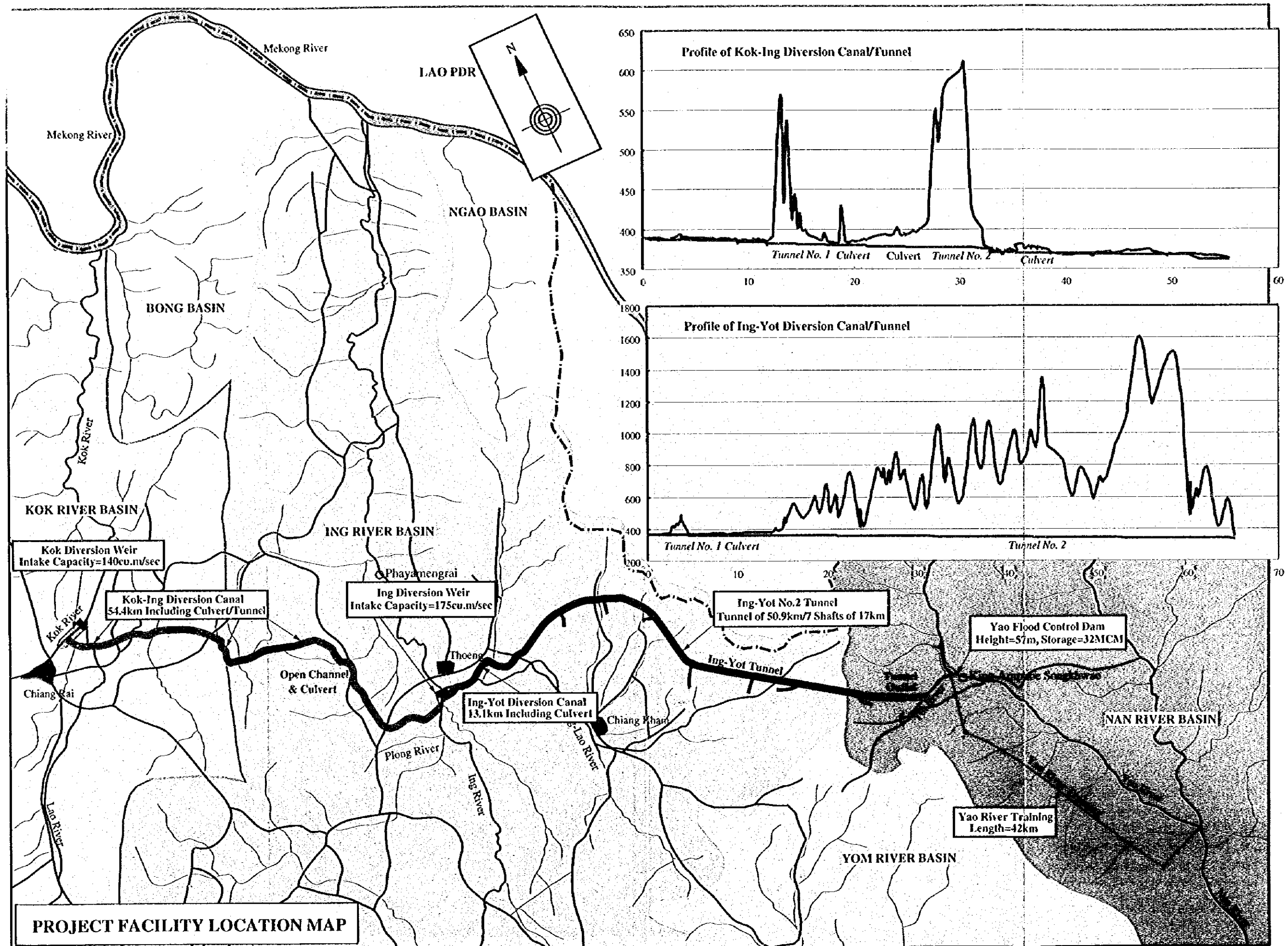
- Existing Dam/Reservoir
- Proposed Dam/Reservoir
- River Course
- Direct/Indirect Irrigation Beneficial Area

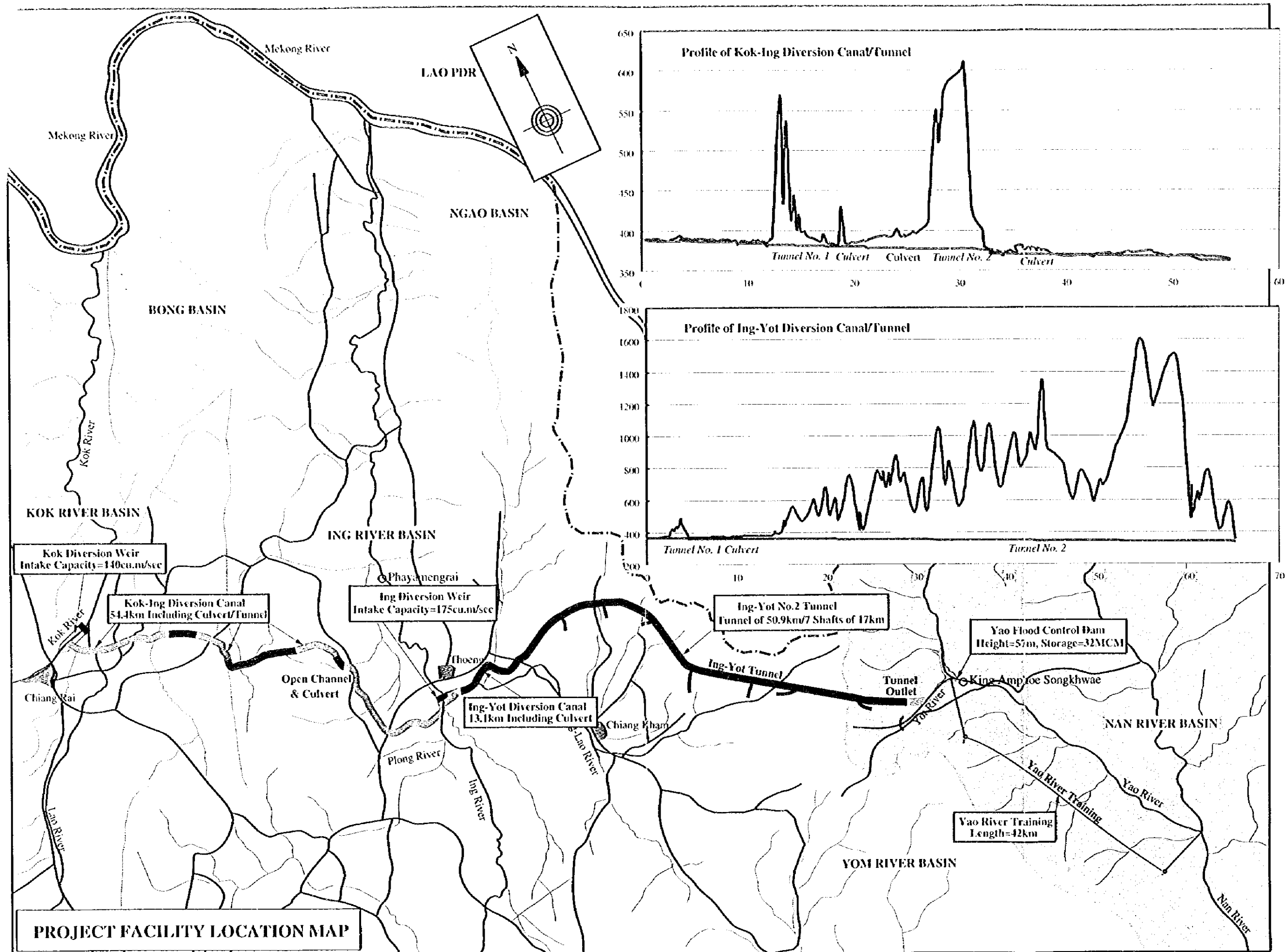


## STUDY AREA LOCATION MAP

THE KOK-ING-NAN WATER  
DIVERSION PROJECT  
IN  
THE KINGDOM OF THAILAND









## Executive Summary

The Kok-Ing-Nan Water Diversion Project is to divert rainy-season 'surplus' water from the Kok and Ing Rivers, both tributaries of the Mekong River, to the Nan river and thus to the Sirikit Dam. The water (2000 MCM) will be used for agricultural, industrial and domestic purposes in the Nan basin and the Chao Phraya Delta, as well as for the conservation of the lower Chao Phraya Delta represented by damages to the paddy field in the lowest reaches due to intrusion of the salty water, in other word, minimum requirement of river flow and security of adequate productivity and prevention of salt damage in the whole Chao Phraya Delta.

This JICA environmental study is founded on principles defined in key Thai government policy statements, and particularly on the King's land and agricultural management initiative ('New Theory'), as illustrated by His Majesty's speech on a community-based or self-sufficient economy: "It is not important for Thailand to become an economic tiger. The important thing is that Thais should live a life that leaves them enough to eat, and that they should rely on their own economy." The approach taken by this JICA study also reflects elements of OEPP's overall policy on natural resources:

- To enhance administration and management of natural resources by systematic decentralization of power and authority from central offices to regional offices, in addition to strengthening relationships among government agencies, the private sector, NGOs and local people.
- To amend the legal and regulatory framework enabling support for more effective administration and management of natural resources, and recognition of rights and responsibilities of local people to demonstrate ownership of resources.

The above-mentioned policy-related matters, worth being considered for a project as large as the Kok-Ing-Nan Project, were reflected in part in OEPP's comments on the IEE report prepared by the JICA study team. Among others the following were considered of particular importance:

- Consideration should be given to ecological impacts and impacts on water users within the donor basins. Provision of water to the population of the donor basins should be the first priority; and
- Given the scale of the project and its wide-ranging impacts, people should be allowed to participate in various stages of project implementation, including the environmental study, so as to avoid conflict between the project and the local population.

The idea of greater public participation is promoted by the new Constitution, the current *National Economic and Social Development Plan* and other policy documents, all of which encourage greater involvement of local communities, particularly through the empowerment of Tambon Administrative Organisations.

In light of these recent policy trends, which place greater importance on local community participation in resource control and environmental management, this JICA supplementary studies will be utilized to strengthen the RID environmental study (EIA), placing more importance on social aspects and people's participation. As a result, it is found indispensable to conduct further participatory rural appraisals in the donor basins, in close collaboration with DCD (Department of Community Development, MOI) in order to promote rural development of the donor basins in the future.

Considering a water diversion plan, an issue of surplus water is of great importance. From a socio-economic survey using PRA in the lower Ing Basin and an inventory survey of traditional People's Irrigation System (PIS) in the Kok and Ing Basins, "the lack of water" was addressed as the most severe problem by the farmers. A shortage of water is very serious in the dry season. In general, very little dry season farming is practised and some villages even suffer from shortages of drinking and domestic water in the dry season. It

is worth noting that, out of 14 PIS groups studied, 5 PIS groups noted shortages of the supplemental irrigation water even in the rainy season as a problem. It is estimated that there is still "surplus water" amounting to more than 3,500MCM at the proposed Kok and Ing weir site, even taking into account water requirement under such assumption that the maximum development be executed in the donor basins of Kok and Ing rivers. However, it will be indispensable to reach mutual consensus among the representatives of the stakeholders through public consultation with the people in the donor basins, the subjects of which are a future plan to provide the people in the area concerned with sufficient water and whether such "surplus water" be recognized to be diverted to another basin. In addition, the detail of the diverted water shall be well informed of the public, from the viewpoint of public disclosure.

Apart from a review of the RID environmental study (EIA), the JICA supplementary studies focused on the social environmental aspects in the donor basins. Although the sample areas were very limited, a socio-economic baseline survey as well as Participatory Rural Appraisal (PRA) was conducted in the Lower Ing Basin and an inventory survey of PIS groups was conducted in the Kok and Ing Basins.

Concerning Environmental Impact Assessment (EIA), it is recently an international trend that the environmental assessment be carried out in early stage of the project formulation, where particular importance is given to the social environment survey. Because learning the development needs of the local people and people's participation are recognised to be highly important from the initial stage of the project formulation.

The development of the northern Thailand is given a rather high priority. As addressed in the OEPP's comments on IEE, the natural resources in the region should be managed for the best use for the region concerned. In order to learn the real development needs in parallel with the execution of the environmental assessment, the social environment survey based on PRA is firstly recommended to be done with close collaboration with DCD, etc. The most importance in learning the development needs, is to examine the needs in a well-balanced manner, from several aspects. It is necessary to learn how deeply the local people by himself understands his own needs. From several methods of social survey, a participatory PRA method has been recognized to be appropriate because diversified needs could be learned in a wide range through dialogue with local people from the planning stage of the development study.

In formulating this kind of huge project, it is quite necessary to pay due attention to information disclosure and transparency, in respecting strengthened power of Tambon Council as well addressed in the new Constitution. In this context, the participatory social environment survey is highly advised to be carried out from now on in a wide range in the Donors Basins. Here, the recommendations to learn the development needs are described as follows.

The primary recommendations of this report are that further social environment studies with a focus of PRA and actual funding be provided for rural development in the donor basins area.

The environmental studies suggest a number of avenues for promoting rural development in the donor area together with supplementing the works of the environmental assessment and mitigating measures carried out by the RID environmental study. The following recommendations arose from these studies:

Recommendations to be raised in the subsequent stage

- further environmental study including handling of the spoil material (the amount of spoil excavated from canal, tunnel construction, etc. estimated at less than 20 million m<sup>3</sup>) and study on spoil utilization;
- implementation of various improvement plans for P.I.S. proposed by the provincial agencies;
- public participation and security of public disclosure and transparency in the project appraisal process;
- the benefits for the beneficiary basin be shared with the donor areas through a Donor Basin Sustainable Development Fund (DBSDF).

Recommendations to be raised in a broader and long-term aspects in due consideration of watershed conservation and sustainable rural development.

- a Co-operative Reforestation Programme and a Forest Protection and Encroachment Prevention Programme be undertaken to improve watershed management;
- Participatory Rural Appraisal be applied to identify themes for rural development;
- assessment of impacts on fisheries, aquatic ecology and freshwater biodiversity be carried out more thoroughly and impartially.

The environmental studies recorded in this report have already identified a number of themes (for project programmes), but these themes should be developed by examining local needs across the donor basins. The needs of the donor basins are rather high, and the environmental degradation is still in progress. Therefore, participatory social environmental survey with PRA is advised to be continuously carried out to identify development need in an appropriate manner.

As potential source for the development in the donors basin, there is Social Investment Fund of World Bank (SIF). RID and DEDP have supported the small irrigation projects in the region concerned, the fund of which could be utilized for this purpose. By establishing the "Watershed Conservation and Information Center" proposed in this report, the information on watershed management are disseminated to the public and projects are recommended to be prepared in a close cooperation among local government, RFD, DOF, local people/NGOs, etc..

The socio-economic baseline survey with PRA as a part of this environmental study was carried out in a very limited area due to insufficient time available. In promoting the rural development in the northern Thailand, it is firstly important to learn the social needs and the problems of local people together with understanding current socio-economic conditions in the donor basins consisting of Kok, Ing and Yao river basins.

Through more in depth public relations activities which are required to provide the people in the donor basin with correct and honest information, the RID will be expected to get more valuable and useful information which will be incorporated into the comprehensive EIA. In parallel to these activities, the social environmental survey with a participatory method such as PRA, will be required to be carried out, particularly in the Lower Ing basin and Yao river, in a wider range to grasp the development needs of the people, which are eventually reflected in the associated projects proposed in the Feasibility Study. Finally, the formulation and implementation of those projects on people's participatory basis will contribute to and result in facilitation of people's consent of the project in the donor basins.





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## ***1. INTRODUCTION***



## 1 INTRODUCTION

RID has employed the Thai consultant group "Team J/V" (Thai Consultant) comprising Team Consulting Engineers Co. LTD, Asdecon Corporation LTD, Panya Consultants CO. LTD and Sanyu Consultants (Thailand) LTD to conduct a feasibility study and an environmental impact assessment (EIA) of the Project. The Study was commenced at March 1996 and completed a May 1999 and its draft final report was submitted to RID at May 1999.

As for the EIA study, Team Consulting Engineers CO. LTD has carried out with responsibility JICA environmental team had reviewed the Initial Environmental Report prepared by Thai Consultants from August 1996 to March 1997 in Phase I study and its report was submitted to RID on March 1997.

JICA environmental team also had carried out the following environmental technical assistant study from January 1998 to August 1999 in Phase II in parallel with the feasibility study of the Project.

Stage 1    Review of Team of Reference for EIA, January to February 1998

Stage 2    (1)    Supplementary Study for Environment, October 1998 to February 1999  
              (2)    Review of EIA report prepared by Thai Consultants  
              (3)    Preparation of the final report for the environmental technical assistant study, July to August 1999.

The Environmental Technical Assistant Report prepared by JICA Environmental Team is composed of the following component.

### (1) Review and Supplement of EIA Report

JICA team had review the EIA report prepared by Thai Consultants and studied the feasibility study report by JICA F/S Team from viewpoint of environmental assessment and prepared the supplemental items.

### (2) Supplementary Study for Environmental Assessment

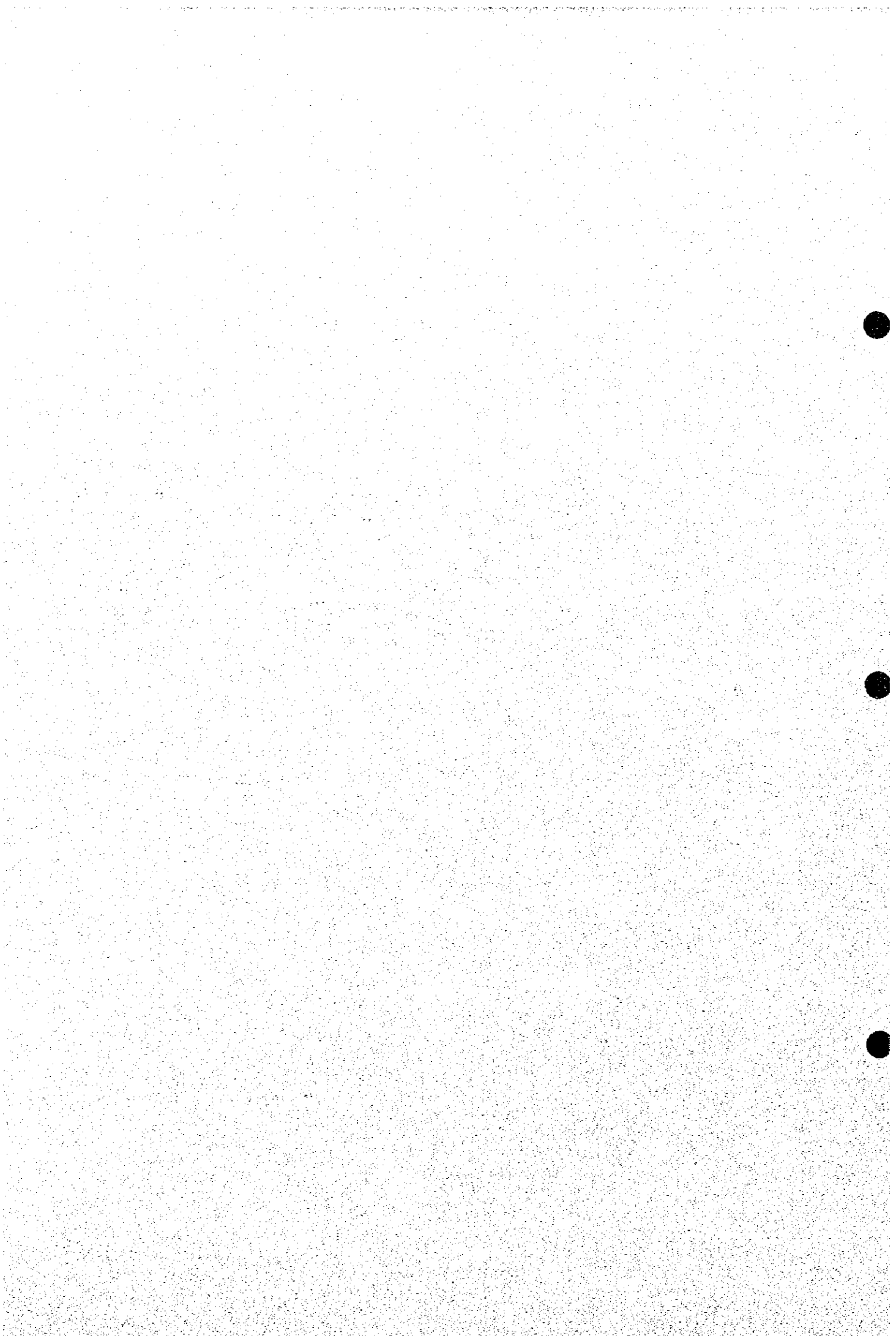
The following Supplementary. Study to broaden and strengthen the environmental assessment carried out by Thai Consultants was performed by JICA Environmental Team in accordance with the study result of I.E.E. Report and Term of Reference for E.I.A. used by Thai Consultants.

- Socio-economic survey in the Lower Ing basin aiming to present an alternative approach to sustainable rural development and to confirm the socio-economic conditions in the basin which will be influenced largely by the Project.
- Watershed management in the basins related to the Project to assess the existing deteriorated watershed by using the satellite image analysis.
- Inventory survey of People Irrigation System in the Kok and Ing basins which will be influenced by the Kok-Ing water diversion canal.
- Study on fisheries, aquatic ecology and freshwater biodiversity.

- Spoil utilization.
- Study on the donor basin sustainable development fund.



## **2. *PROJECT OUTLINE***



## 2 PROJECT OUTLINE

The Kok-Ing-Nan Water Diversion Project is to divert rainy-season 'surplus' water from the Kok and Ing Rivers, both tributaries of the Mekong River, to the Nan river and thus to the Sirikit Dam. The water will be used for agricultural, industrial and domestic purposes in the Nan basin and the Chao Phraya Delta, which are the main beneficiary area of the proposed water diversion project. The project is a trans-basin plan. The Kok and Ing basins from which water be taken for water diversion, can be defined as "Donor Basins". On the other hand, the Yao river, through which the diverted water passes, can be defined as "Incommoded Basin", were a large amount of water only flows in a rainy season. These basins are located in northern Thailand, Chiang Rai, Phayao and Nan provinces. The Proposed project facilities consists on open canals (about 40 km), culverts (about 18 km), tunnels (about 61 km) and river training (about 28 km). The volume of diverted water is estimated at 2,000 MCM<sup>1</sup> per annum and at the rate of up to 175 m<sup>3</sup>/second at maximum.

The diversion canals and tunnels of about 150 km long, consisting of the following facilities, are required by the Project.

- |                              |  |
|------------------------------|--|
| - Kok Intake                 | At the intake structure to be constructed immediate upstream of the existing Chiang Rai weir, water is diverted from the Kok river with water levels raised by the Chiang Rai weir.  |
| - Kok to Ing Diversion Canal | A series of open canal, siphon, tunnel and culvert with a total length of 54.4 km and a capacity of 150 cu.m/sec to link the Kok intake and the Ing diversion weir.  |
| - Ing Diversion Weir         | A rubber-type weir constructed on the Ing river near Amphoe Thoeng to divert 175 cu.m/sec of water from the Ing river together with the water diverted from the Kok river.   |
| - Lao Diversion Canal        | Diversion canal of 11.1 km long and 175 cu.m/sec capacity to connect the Ing diversion weir and the Ing to Yot tunnel, consisting of open canal, siphon, tunnel and culvert.   |
| - Ing-Yot Tunnel             | The diversion tunnel of 52.9 km long and 175 cu.m/sec capacity with 7 adits of 17.4 km long in total is planned to transport the water from the Ing basin to the Nan basin connecting the outlet of the Lao diversion canal and the Yot river, a tributary of the Yao river. |
| - Yao Flood Control Dam      | This works to control a peak flood during wet season from the upstream reaches of the Yao river and to provide in dry season irrigation water to the beneficiary areas situated along the Yao and Nan rivers.  |
| - Yao River Training Works   | Improvement works of Yao river channel extending over 41.9 km to let the 200 cu.m/sec at most of discharge flow smoothly.  |

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<sup>1</sup> Million cubic metres.

### **3. *REVIEW AND SUPPLEMENT FOR EIA REPORT***

### 3 REVIEW AND SUPPLEMENT FOR EIA REPORT

The EIA report prepared by Thai Side consists of the following Seven Chapters,

- Chapter 1 Introduction
- Chapter 2 Project Feature
- Chapter 3 Existing Environmental Conditions
- Chapter 4 Environmental Impact Assessment
- Chapter 5 Mitigation Measures
- Chapter 6 Monitoring Program
- Chapter 7 Public Relation

This EIA study is conducted based on the Terms of Reference for EIA prepared by Faculty of Engineering and Faculty of Science, Chulalong Korn University.

The report content in Chapter 3 Existing Environmental Conditions covers sufficiently the conditions of the physical resources, ecological resources, human use values and quality of life in three basins of Kok, Ing and upper Nan where the Project site is located.

The contents in Chapter 4 Environmental Impact Assessment and Chapter 5 Mitigation Measures describe the environment impact by the Project and its mitigation measures. Though the contents address many important issues for the impact, some supplements are necessary to promote the Project implementation successfully and smoothly.

The contents in Chapter 6 and 7 also are well prepared. However, it is necessary to recommend strongly to continue the further monitoring and public relation work by government based on the issues mentioned in Feasibility Report and EIA Report in order to maintain the better environmental conditions in the basins and obtain the people participation.

#### 3.1 Existing Environment Condition

In order to be able to understand clearly and judge properly the existing environmental conditions in the basins and the Project area, it is desirable to supplement the following items, the detail of which is discussed in the Main Report.

##### (1) Physical Resources

###### Ground Water

It is necessary in future to survey and study the groundwater in the lower Ing basin which is located between the Ing weir site and river mouth because the lower area along the river has been inundated always in the wet season by the Ing flood and the Mekong backwater and may preserve the groundwater with shallow depth which could be developed for domestic and irrigation use.

###### Surface Water

Though the surface water study for the Kok, Ing and Nan rivers is well prepared in EIA Report showing the flow diagram of three rivers and monthly runoff fluctuation, it is desirable to supplement the following items.

(a) Observation of River Flow

It is necessary urgently to install the gaging stations and observe the water level and discharge at the following sites which have no observation data at present.

- The downstream of Ing-Lao river, which has brought about the large flood and sedimentation into the Ing river.
- The lower Ing river, where the water level is largely fluctuated in the wet season by the Mekong backwater (Three sites where JICA proposed the weirs to store the water in river channel and use it for irrigation and fish culture in the dry season)
- The proposed Yao damsite to objective and evaluate the peak flood discharge at the damsite.

(b) Surplus Water in Kok and Ing River

It is desirable to describe the surplus runoff a the downstream rivers of Chiang Rai weir site in the Kok and Ing weir site in the Ing river in order to proof the sufficient surplus runoff n the wet season.

- The existing surplus water at the downstream of the Kok and Ing river is estimated as follows;

River	Catchment Area (km <sup>2</sup> )	Wet Season	Dry Season	Total
(1) Kok River				
At Chiang Rai Weir Site	6,050	2,510	710	3,220
At GNI, Chan Chiang	10,300	3,870	940	4,810
At River Month	10,880	4,170	1,020	5,190
(2) Ing River				
At Ing Weir Site	4,240	1,100	110	1,210
At IN at Thoeng	5,700	1,670	170	1,840
At River Month	7,120	2,180	230	2,410

Remark; The above runoff is mean value in the recent year 1985-96.

(c) Backwater Influence of Mekong River

Since the Mekong river has a large water level fluctuation of 10 to 12m at the Kok and Ing river mouth, the downstream river reach of 30 km from the Kok river mouth and 90 km from the Ing river mouth will be influenced by the backwater of the Mekong river in the wet season, because the river slope is very gentle as 1/3,000 in the Kok downstream and 1/9,000 in the Ing. Namely the downstream river reach of both rivers will not be influenced by the diversion water in the Project.

(2) Ecological Resources

Aquatic Ecology and Fishery Resources

- The lower basin of the Kok and Ing forms the adjoining to the Mekong river and forms the very important basin for aquatic ecology and fishery resources. However, the lower Ing basin is dried up in the dry season and has brought the large impact to fishery resources.

- There are existing a number of weirs constructed by farmers in the tributary and main river of the Kok-Lao and the upper Ing. Those weirs have obstructed fish migrant to the upstream river.

#### Forest Resources

- Forest resources in three watershed have been deteriorated by slash-burn cultivation and tree cutting by mountain tribes as shown in the watershed conditions analyzed by the satellite image in JICA survey.
- The mountain areas along the tunnel route is mostly covered with the national park and watershed classification 1A and 1B. Particular care shall be required for selection of tunnel route and entrance position of tunnel and adit.
- There are cool climate, clean water in tributaries and beautiful landscape in the mountain forest area along the tunnel route. Those forest areas will become the eco-tourism area in future which is going to be promoted by RFD.

### (3) Human Use Values

#### Water Use/Irrigation

In accordance with JICA F/S Report, those existing large irrigation area in the Ing basin could be irrigated by gravity system operating regulators and turnouts installed in the canal and providing new irrigation canal to connect the diversion canal.

Since the Kok river has sufficient surplus runoff even in the dry season, those irrigation area could be irrigated in the dry season by the diverting the Kok dry season water.

- A part of diversion water is released to the Tak river at the end of culvert canal connecting to No.1 Kok-Ing tunnel outlet and conveyed through the Tak river. This diversion water will be used for the existing farm area being suffered from water shortage at the Tak basin.

### 3.2 EIA and Mitigation Measures

Supplement for EIA by the Project and its mitigation measures is studied mainly based on JICA feasibility study report after reviewing EIA report by Thai Consultants.

Supplement by JICA study are summarized based on the Term of Reference prepared by Chulalong Kom University and used by Thai Consultants for this EIA study.

#### (1) Important Area to Concentrate the Study on the Impact of the Project

The important areas to assess the impact of the Project are the lower Kok and lower Ing basins located at the downstream of the water diversion route and the upper Nan basin, especially the Yao river basin. The supplements for the impact of the Project and its mitigation measures are as follows;

##### Lower Kok Basin

The water diversion in dry season to supply the irrigation water for the lower Ing basin will bring about some influence for fish migrant due to small surplus water of 1,000 MCM in dry season.

The water diversion control in the dry season shall be carefully studied in future taking into account fish species and fish migrant status in the dry season.

#### Lower Ing Basin

- The lowland area along the lower Ing river with the long river length of 140 km between the Ing weir and the river mouth also have faced inundation problem during flood season. The inundation problem at the upper river reach of 70 to 80 km could be mitigated by the diverting water of 175 cu.m/sec at the Ing weir. It is difficult however to mitigate the problem at the lower river reach of 60 to 70 km near the river mouth due to a backwater of the Mekong river invading into the lower Ing river in wet season.
- The lower Ing river has no or very scarce runoff in the dry season, because the upper Ing basin has used fully the dry season runoff for irrigated agriculture. There are accordingly no irrigated agriculture and no fish migrant in the dry season in the lower Ing basin.
- JICA feasibility report proposes three weirs along the lower Ing river to store the wet season surplus water at the river channel with very gentle slope of 1 to 9,000 to 10,000 and to regulate the dry season water from the Ing-Lao, Ing return flow and the Kok river by diversion canal of the Project. When this weir project will be implemented together with the water diversion canal project, the irrigated agriculture could be promoted at the lowland area along the lower Ing river and fish culture at the channel reservoir in the dry season also will be possible.

#### Yao River Basin

The Yao river basin is the incommoded basin receives the large impact by the Project because the bulk diversion water of 175 cu.m/sec has to be released through the river with small discharge capacity and steep slope. The flood control dam to control the peak flood at the Yao basin and the diversion water of 175 cu.m/sec and the river training to release the diversion water and discharge at the Yao own basin shall be provided. There are existing upland farm area to be submerged in the Yao reservoir and a number of villages along the Yao river which will be suffered from the bulk water release in the wet season.

### (2) Location of Diversion Points

#### Existing Chiang Rai Weir

The Chiang Rai weir has not fishway to migrate from the Mekong river to the upstream of the Kok river.

Several weirs also are constructed in the Kok-Lao river which joins at the downstream of the Chiang Rai weir but have no provision of fishways. The following mitigation measures for the above environmental impact will be required;

- River bed reinforcement at the downstream of the Chiang Rai weir to prevent the scoring.
- Provision of fishway which will be proposed at the route from the Lao river mouth connecting with the Kok river at the downstream of Chiang Rai weir to the right bank of the weir. This proposed route is the original course of the Kok river before construction of the weir. Fishes being obstructed by the existing weirs in the Lao river could migrate to the Kok upstream from the Mekong river through the above route.



- The existing intake water level of 389m at Chiang Rai weir is mainly designed to divert the Kok water in the dry season to the people irrigation area. If the water level of 389m is maintained in the flood season, its back water will bring about inundation problem at the upstream Chiang Rai area. The operation water level at the weir in the flood season shall be carefully reviewed.

### (3) Diversion Canal Route and Ing Weir Site

The environmental impact and mitigation measures for the diversion canal route from the Kok to the Ing and from the Ing to Ing-Yot tunnel as well as the new Ing weir site are summarized as follows;

#### Kok-Ing Diversion Canal Route

- Possibility of irrigation and fishpond water supply from the diversion open canal to the beneficiaries at the project site.
- Safety measures for deep excavation at the culvert construction site.
- Spoil bank for excavation materials and borrow area for fill materials taking into account the place, volume and treatment method.
- Disposal of excavated materials from canal construction.

#### Ing Weir

The Ing weir is proposed at 2.8 km upstream of the Thoeng Bridge on the provincial road with the code No.1020. At the weir site, the Ing river has a catchment area of 4,440 km<sup>2</sup> and the annual runoff amount of 1,830 MCM.

The river flow during the wet season changes from 30 cu.m/sec in June to 100 cu.m/sec in August to September in the peak wet season on an average. Since the flow discharges during the wet season in the Ing river is insufficient to satisfy the design discharge of 175 cu.m/sec, the diversion water from the Kok river is necessary to supplement it.

The wide flood prone areas spread along the Ing river from the downstream of the proposed weir site to the confluence with the Mekong river. These areas have suffered from the inundation with a long duration through the wet season due to insufficient flow capacity and the back-water effect of the Mekong river. There is a high possibility that the diversion of river water in the Ing river during the peak wet season will reduce the flood water level significantly in the river reaches.

While, during the dry season, the Ing river has no significant water for cultivating the aforesaid flood prone areas located along the downstream reaches of the Ing river. The Project may be able to contribute development of land resources along the downstream river reaches.

#### Ing-Yot Diversion Canal Route

The Ing-Yot diversion canal is proposed to convey the water regulated in the Ing reservoir from the intake in the Ing weir to the inlet of Ing-Yot No.2 tunnel. The canal however shall pass through the very complicated and difficult area for construction such as the Ing flood plain, the area near village and temple, right bank mountain with poor geological condition, the Lao river with meandering shape, the high land at the right bank of the Lao river, etc.

In order to avoid the tunnel construction at the mountain with the poor geological condition, the alternative route to access the Lao river by the open canal and culvert along the existing provincial road will be studied. It will be necessary however to get the consent of village peoples to select this alternative route because the route requires a large farmland acquisition and changes of the Lao river course, where the river water have been used for irrigation by village peoples.

#### (4) Tunnel Route

The tunnel shall be planned and designed taking into account the following safety and mitigation measures for the environment impact along the tunnel route.

- Countermeasures to prevent the leakage through poor geological formation at the inlet and outlet of the tunnel as well as the inlet of adits in order to preserve the existing forest area above the entrance of the tunnel and adits.
- Safety measures for the tunnel construction such as electrical, lighting, ventilating, drainage and water supply inside tunnel.
- Treatment facility and proper operation for the polluted drainage water brought from tunnel.
- Tunnel construction method using tunnel excavation machine instead of dynamite blasting method is adopted after due consideration given to the environmental conditions in mountain area.
- Spoil bank of the tunnel excavation materials taking into account quantity and quality of the materials, spoil bank area, treatment method of the materials using method of the spoil are, etc.
- Spoil utilization

#### (5) Flood Control Dam Site

The flood control dam is proposed at 1.5 km upstream of the village named as King Amphoe Song Khwae. The dam site has a catchment area of 372 km<sup>2</sup> and the mean annual runoff of 175 MCM. The flow runoff during the wet season occupies 85% of the annual runoff.

Applying the reservoir water level of EL. 320m, there is no villages, national park and reserved areas in the reservoir area, though there exists farm area of 520rai, or equivalent to 83 ha in the reservoir area, which requires land acquisition.

#### (6) Yao River

The Project will convey the large amount of water during the wet season to the Yao river, which has flood problems even under the present flow condition. It is necessary to carefully study the impacts on hydraulic and hydrological change and to identify appropriate measures, as well as to mitigate flood damages along the Yao river. The potential impacts are discussed in the JICA Supplemental Study.

## (7) Specific Physical Environment

### Characteristics of Water from One River to Another

The Project is the transbasin project, which the water in the Kok and Ing is conveyed to the Nan river. The Physio-chemical properties of the water in both basins are mostly same in accordance with Thai Consultants study. This issue is discussed in the JICA Supplemental Study.

### Mitigation to Drought Conditions in Dry Season

People irrigation area along the proposed diversion canal route in the Kok, Tak and Ing basin and the lower Ing basin located downstream the Ing Weir site have been suffered from water shortage every year in dry season due to no rainfall and less runoff in the river. Those drought conditions will be remarkably improved by supplying the dry season water from the water diversion canal of the Project and the proposed associate irrigation project.

### Bio-diversity and Biological Aspects

This issue is discussed briefly in the JICA Supplementary Study

## 3.3 Summary of Environmental Consideration in Project Facilities Alternative Study

As for the route and site of the Project facility, various alternative plans are studied taking into account not only the engineering works but also the environmental impact of the Project and mitigation measure.

The summary of alternative study result is shown the following Table 3.3.1.

Table 3.3.1. Environmental Considerations in Project Facilities Alternative Study.

Project Component	Alternatives considered	Environmental aspects considered	Advantages of selected alternative from environmental viewpoint	Remarks
Kok diversion weir site	Two alternative sites	Flooding problem; river dredging difficulty; avoidance of sedimentation in the main canal.	Existing Chiang Rai weir to be used; new intake 2 km upstream of the weir site; flood control achieved; no impact on on-going river dredging works; sedimentation in main canal countered by appropriate intake design with a sediment Pond.	Appropriate intake design with sediment pond being studied.

Project Component	Alternatives considered	Environmental aspects considered	Advantages of selected alternative from environmental viewpoint	Remarks
<b>Kok-Ing diversion canal</b>				
Diversion canal in Kok basin	Three alternative routes	Social impacts on resettlement and impact on PIS; impacts on wetlands; avoidance of deep excavation. Lowering groundwater level in deep excavation of canal.	Impact on PIS minimised; appropriate crossing structures to be provided; open canal design without any deep excavation; avoided urban/ peri-urban area and resettlement.	Additional studies on PIS being conducted to clarify impacts and propose measures; productive irrigated paddy land may be lost - need for adequate compensation; adequacy of various crossing structures being studied.
Diversion canal from Kok to Tak - No.1 Tunnel, Open and Culvert canal in Tak basin, No.2 Tunnel	Two alternative routes	Avoid watershed class 1A, 1B and national parks and wildlife sanctuaries completely; avoid conservation forest area, and prime agricultural areas; avoid or minimise impacts on PIS and resettlement; avoid deep excavation as far as possible.	Important Nong Luang area avoided; deep excavation culvert length reduced; mountainous areas with poor geological conditions avoided.	Land use, resettlement, forest cover and wildlife aspects are being studied in detail at all project facility locations, along proposed route and construction access roads; deep excavation areas - appropriate drainage system, slope protection works being studied.
<b>Diversion canal in Ing basin</b>				
Culvert canal at Ban Huai Kang Rat and open canal in the Ing basin	Three alternative routes	Avoid watershed class 1A, 1B and national parks and wildlife sanctuaries completely; avoid conservation forest area, and prime agricultural area; avoid or minimise impacts on PIS and resettlement; avoid deep excavation as far as possible.	Regulation pond requiring large farm area to control fluctuation in discharge not necessary. The culverted canal at Ban Huai Kang Rat will not experience problems with landslides, high volumes of seepage water, etc., in the deep excavation works. The open concrete-lined canal in the Ing basin to be designed with adequate balance of excavated and fill volume to reduce spoil-bank area and borrow area requirements.	Deep excavation areas - the balance of excavation and fill volume, appropriate drainage systems, slope protection works, spoil bank and borrow area characteristics are all being studied in detail. Crossing structures such as siphons, culverted drains, aqueducts, bridges, etc., are all being surveyed and studied. The adequacy of Mae Loi river for diverting water to the weir site is being studied.
Ing diversion weir and intake site	Two alternative sites	Avoid any impacts on temple in Amphoe Thoeng; preserve current river flood control regulation function as well as existing natural environmental condition.	Diversion dam site selected 2 km upstream from temple; intake structure planned 100 m upstream of proposed dam axis on the right bank.	Diversion dam with rubber gate proposed to retain flood control regulation and existing natural environmental conditions; detailed study of fish migration being carried out.

Project Component	Alternatives considered	Environmental aspects considered	Advantages of selected alternative from environmental viewpoint	Remarks
Lao diversion canal route: open canal along right bank of river, culvert along Lao river, culvert through hilly area	Three alternative routes	Avoid tunnels in areas with poor geological conditions; avoid or minimise deep excavation; minimise impact on Lao river; avoid resettlement and impact on important temple.	Excavation for culvert canals along river canal easy to carry out as excavation material is mostly earth and fine sand; tunnels not required in difficult areas.	The culvert route along the Lao river and hilly area is very complicated and excavation works are rather difficult. This route is being studied in detail taking into account river training of Lao and suitable construction method for deep excavation.
Ing-Yot long tunnel	Northern and southern routes: both in turn including two alternative routes; thus in all four alternative routes	Avoidance of areas of watershed class 1A & 1B, national parks and wildlife sanctuaries; avoidance of conservation forest area, and prime agricultural areas. Avoidance or minimisation of impacts on PIS and resettlement. Avoidance of deep excavation as far as possible. Avoidance or minimisation of impacts of resettlement and farming activities; road condition to minimise construction of new roads in mountain areas; avoidance of impacts on tourist areas; avoidance of tunnel construction in alluvial plains and in areas of poor geological conditions; minimise impacts on existing roads, villages, and streams.	Tunnel route placed in northern high mountain area consisting of consolidated and firm rock foundation; tunnel entrance, exit and adit locations avoid 1A watershed areas.	Land use, forest cover, wildlife aspects are being studied in detail at tunnel inlet and outlet locations, adit locations, access road areas, and tunnel spoil disposal areas; proposed tunnel route passes through several limestone rock formation areas where important issue is removal of groundwater/ spring water. Impact on Phu Sang waterfall and spring also needs to be assessed.
Yao Flood control dam	Two alternative sites	Flood protection of communities in the watershed; avoid or minimise resettlement.	No resettlement is involved; proposed inundation area has poor vegetation cover.	Upstream basin of Yao river is completely degraded with hardly any tree cover; peak flood from basin is being analysed.

Project Component	Alternatives considered	Environmental aspects considered	Advantages of selected alternative from environmental viewpoint	Remarks
River training works in Yao river	Various inter-related river training works	Minimise resettlement; provide flood protection; safety considerations; minimise impact on infrastructure.	Improved flood protection.	Various components of river-training works being studied, e.g. waterway facility, provision of drop structure, river-channel excavation, provision of flood dikes, provision of revetment work for improved river channel, replacement or upgrading of bridges and other crossing structures; project's impacts on natural environment and human settlements significant; socio-economic situation of affected population being studied.

### 3.4 Technical Adequacy of EIA Report

The EIA Report presents baseline environmental data concerning environmental aspects compiled through secondary data review, field surveys, investigations and sampling programmes. Based on these data social and natural environmental components' existing conditions have been identified. The summary tables for reviewing the EIA Report are presented in Appendix.

Impacts vary according to the considered project component and environmental parameter, and in many cases these are inter-related. OEPP in its Guidelines stresses the importance of determining the severity of impacts whether negative or positive, to humans in each element. In other words, the social environmental impacts and adequacy of public consultations as well as public opinions of affected people are extremely important. Therefore, the outline and the function of the structures and their expected impacts should be informed of the public in a correct and proper manner.

The EIA Report discusses construction and operation stage impacts and mitigation measures. The following comments concerning specific environmental parameters need to be noted and studied in detail in subsequent stages:

- **Groundwater** – The significance of the impacts of tunnelling and excavation of deep channel sections on the groundwater resources is advised to be addressed. There are both shallow and deep aquifers to be found along the diversion route and many of these feed the streams, rivers and springs in the mountain areas.
- **Hydrology and surface water quality** – Water pollution resulting from tunnel construction is produced by groundwater seepage, drilling water and wastewater from construction labour force camps. These aspects need to be studied in detail in subsequent stages.
- The impacts on water resources due to construction or improvement of access roads that have perennial streams flowing near or along the planned access roads should be adequately addressed, referring to the existing road condition.

- **Aquatic ecology and fishery resources** – The significance of environmental impacts is largely understated.

The following issues are discussed briefly in the JICA Supplementary Studies:

- Assessment of Existing Fisheries and Aquaculture Production
  - Potential Impacts on Hydraulic Structures and Fish Movement and Migration
  - Potential Impacts on Flood Fisheries in the Kok and Ing Basin
  - Potential Impacts of Trans-basin Transfer of Water on Aquatic Ecology and Fisheries
  - Potential Impacts of Yao River Training on Fisheries and Aquatic Ecology
- **Forest resources** – The impacts due to construction or improvement of access roads on the forest resources of the area are not assessed adequately. These impacts in terms of providing improved access to forests previously difficult to reach have great significance in both project construction and operation stages due to the strong demand for wood for home fuel.
  - **Water use / irrigation** – The impacts on existing water use of water resources in the right of way (ROW) of the KIN facilities are assessed not to be significant so long as adequate temporary drainage facilities are provided during the construction stage. There are no estimates of water demand for construction of the KIN project. These aspects require study to formulate more concrete mitigation measures to minimise the impact on available water resources.
  - **Social and economic issues** – While impacts due to the loss of agricultural land and consequent income loss to project affected persons in the donor basins have been determined, measures in terms of policies and projects aimed at improving donor basin development, economy and social well-being are limited.

The following specific project works and their impacts and mitigation measures have wide-ranging implications on several environmental parameters:

- Tunnelling-related impacts of construction (including access roads and spoil material stockpiling areas) particularly related to impacts on surface water quality and drainage, and on groundwater, at all tunnel inlet, outlet and adit locations.
- Site management of all locations proposed to be used for stockpiling or disposal of spoil material resulting from canal excavation and from tunnelling.
- The Impacts of the Nam Yao river-training works, particularly those related to the human and social environment (e.g. use of the river for domestic, livestock, navigational and fisheries purposes) and impact on aquatic ecology.

### 3.5 Further Action/ Work

Firstly, consultations with OEPP are necessary as a first step to obtain feedback on the EIA Report and all works carried out by the JICA Study Team. Based on OEPP's comments and on those presented above, RID needs to further refine the EIA Report. The final EIA Report has to consolidate and bring together all information into one stand-alone volume, so that it can be submitted formally to OEPP to initiate the EIA approval process. This will also facilitate submission of the EIA Report to donor agencies if the need arises at a later date.

Secondly, if the EIA gets approval (with or without conditions) from OEPP and the project goes into the next detailed design phase, further environmental studies by RID should be focused on detailing environmental mitigation measures, the outlined EMP, and in refining the proposed environmental monitoring. The environmental monitoring has to relate closely with the mitigation measures and EMP, as

well as to the available budget. The institutional and management requirements within RID also need to be defined at this stage and training determined.

Providing that the EIA gets OEPP approval with conditions of administrative and/or budgetary concerned with governmental agencies, especially in the EIMP, the approval conditions will be submitted through NEB to the Cabinet for resolution.

Thirdly, RID needs to further improve its public awareness programme in areas where there are significant impacts. This is to control the spread of misleading information and to make people aware of the various steps that are being taken at the different project stages and of the supporting projects being planned to minimise negative impacts and increase benefits.



#### **4. *SUPPLEMENTARY STUDIES***



## **4 SUPPLEMENTARY STUDIES**

### **4.1 Watershed Management**

#### **(1) Introduction**

Thailand is currently facing problems associated with natural resource management and degradation of environmental quality including loss of forestry resources and biodiversity, soil erosion, siltation of rivers and watercourses, saline intrusion of aquifers, pollution and increased flooding. The problems are partly caused by social and economic change, which has been particularly significant during the last thirty years. Changes include population growth and rapid economic growth, which has accelerated the rate of utilisation of natural resources, while the availability of non-renewable resources, has become increasingly scarce.

One of the most significant changes in Thailand in the last twenty-five years has been change in land-use and the conversion of naturally forested areas to agricultural land. Forest cover in Thailand has decreased from approximately 53% in 1961 to less than 26% in 1995. The depletion of forest areas has mainly been caused by promoting of timber export by cutting and the conversion of forested areas to agricultural land to provide subsistence food for the rapidly increasing population as well as agronomic expansion for commercial crops.

A large proportion of the change in land use has been the conversion of forested areas in the valleys and lowland plains for development of paddy fields for the production of rice and the development of areas for the cultivation of vegetable crops. However, a significant change in land use has also occurred in the more sensitive upland areas, leading to increased soil erosion and increased volumes of more rapid run-off, particularly on steeper slopes.

#### **(2) Watershed Degradation**

In upland areas, hill-tribe people have settled and have relied mainly on land use practices such as shifting cultivation (slash and burn) or swidden agriculture. In the past, cultivated lands in the upper watershed areas were mainly managed for the production of subsistence food. However, in the last few decades, cultivated land has been expanded and intensified for the production of commercial cash crops, which has caused rapid loss of forestry resources. The loss of forest areas has not only caused soil erosion and increased run-off but also contamination of surface waters and groundwater from pesticides and fertilisers used in crop production.

The changes in water and land use in Thailand, and their associated impacts, cannot be simplistically attributed to shifting cultivation practices in upper watershed areas, exacerbated by increased production of cash crops for income generation. Moreover, the changes reflect more adequately the cumulative effects of the transformation of highland areas and hill-tribe agriculture due to a range of factors including:

- illegal logging and over exploitation of forestry;
- the Royal Thai Government's opium substitution;
- accelerated contact between hill-tribe villages and urban and regional centres through the development of transportation networks;
- continued movement of hill-tribe peoples and in-migration to upper watershed areas; and

- national claims on upper watershed areas for the purposes of education, recreation and the conservation of the natural environment which continue to have significant impacts in terms of restricting land-use by local communities.

In addition, a range of other factors have contributed to overall degradation of Thailand's watershed resources including:

- uncontrolled burning and forest fires as a result of slash and burn cultivation, burning to flush out animals during hunting or just malevolent fire lighting not only damages forest trees, but destroys ground cover and leads to combustion of the organic component of the soil leading to damage to soil structure, soil erosion and increased run-off;
- poorly planned and managed road construction in upland areas which is a major source of soil erosion and sedimentation; and
- exploitation of mineral resources and poor rehabilitation of mining areas, particularly open-cast mining areas.

### (3) Watershed Classification as a Tool for Watershed Management

Thailand passed laws in the 1970's that set strict controls on the cutting of timber and exporting of teak, which aimed to conserve government forestry reserves and to prevent further continued watershed degradation. The enforcement of this legislation has not been successful. It has been estimated that if the rate of deforestation continues forest reserves could vanish completely by early in the next century.

The loss of forestry reserves, severe drought and floods and issues relating to exploitation of mineral resources, resulted in the identification of a need for watershed classification as a vehicle for land and water resources planning and management for sustainable socio-economic development. The first watershed classification programme was approved by Cabinet resolution on 28/5/85. The Royal Thai Government adopted the National Watershed Classification regulation on 21/2/95.

The major objective of the watershed classification system is to formulate land use plans for the conservation and sustainable use of natural resources. Watershed classification has been described as the macro land-use-planning tool in Thailand for the sustainable development of water resources.<sup>2</sup>

### (4) Watershed Management Programmes

Over 20 Government Departments and Divisions have responsibilities relating to watershed management.<sup>3</sup> However, the Royal Forestry Department plays a key role, particularly in management of headwaters or head watershed areas. This is primarily because a large proportion of these areas are forestry reserves, National Parks, and Wildlife Sanctuaries, which are the main responsibility of RFD.

According to the watershed management classification promulgated by Cabinet Resolution, approximately 18% of the country (c. 58 million rai) has been classified as WSC 1 and about 8% (27 million rai) has been classified as WSC 2. Therefore, over 25% of the country is classified as a head watershed area.

<sup>2</sup> Tangham, N. (1996), *Watershed Classification: Macro Land Use Planning for the Sustainable Development of Water Resources*.

<sup>3</sup> Coffey MPW/World Bank (1996) Northern Watershed Management Project.

Watershed Class 1 is protected or conservation forest and must be strictly maintained as a headwater source. Immediate reforestation programmes must be implemented where forest resources have been lost. Many strategies have been developed to protect such areas. However, LANDSAT imagery from 1993 indicates that over 2.75 million rai of forestry areas designated as WSC 1 have been encroached.

RFD has established many initiatives to manage watersheds and has nearly 200 watershed management units throughout the country. The main activities of these units are: reforestation; grass introduction; check dams; and community development.

#### (5) The Requirement and Objectives for Watershed Management in the Donor Basins

Watershed management is particularly significant for the "donor basins" in the project area, as without sustainable management of these basins the very viability and future sustainable life of the Kok-Ing-Nan Project might be compromised, due to changes in the natural hydrology of the river systems. In order to assess what watershed management strategies are required to ensure sustainable watershed management in the donor basins it is necessary to assess the current status of land management in the donor basins. In order to more fully understand the different issues relating to watershed management across the project area, a number of basins were selected for detailed studies. The results of the case studies were then used to develop a series of recommendations for watershed management planning.

#### (6) Recommendations for Watershed Management Planning

##### (a) Co-operative Reforestation Programme

The Tambon Administrative Organisations (TAOs) are now empowered to plan for the management of natural resources. RFD Watershed Management Division, other government agencies, NGOs and project Community Co-ordinators are now required act as advisors to the TAO and support their management initiatives.

The plan includes for measures for conservation of soil and water resources, agricultural extension, forest rehabilitation and encroachment prevention and other management options required for sustainable watershed management. The approach has a particular emphasis on participatory watershed management and advocates a "bottom-up" approach wherever possible.

The Watershed Management Plan for the donor basins is divided into several components that are described in more detail in the subsequent sections.

Study and Planning Programme: Participatory Watershed Planning is required for all of the donor basin areas and needs to be implemented by the TAOs with support from RFD staff.

Administration and Management Programme: In order to implement reforestation programmes and natural forest protection activities administrative functions and management of the programme needs to be considered.

Public Awareness and Information Dissemination Programme: In order to ensure success of the watershed management initiatives it will be necessary to raise public awareness and educate the public as to the importance of sustainable watershed management through dissemination of information.

Evaluation and Monitoring Programme: Generally, the success or failure of any reforestation initiative in Thailand has been monitored and evaluated by government agencies or committees, except for those projects supported by international fund agencies. The process has not always been successful and has often resulted in wasted resources. An approach of participatory monitoring and participatory evaluation is therefore recommended for the Kok-Ing-Nan watershed rehabilitation projects. Local participatory groups should implement evaluation and monitoring systems.

**(b) Forest Protection and Encroachment Prevention Programme**

The published literature and the case studies support the requirement for forestry conservation as a means of maintenance of watershed functions, in particular, soil and water resources. Many villagers are well aware of the need for forest protection and are implementing various activities to protect forest areas around their own water resources for the purpose of maintaining water supplies.

Efforts should be made to increase awareness of the need to maintain the existing forest area and to improve its management by planting more trees. Improved monitoring of forest use by the local people is also required.

Encroachment Prevention: It is impossible to guarantee that existing forest areas are not encroached further. However, the case studies indicate that it is not an unachievable goal. Already, some villages are protecting forest areas and enforcing rules against encroachment. This should be encouraged and promoted wherever possible.

Development of Sustainable agriculture Systems for Encroachment Management: The aim of farming system development (FSD) is to rapidly identify useful local practices, as well as introduce new technology, for the benefit of small farmers. Agriculture extension workers assist families to help identify farm management practices that fit local ecological and socio-economic conditions. Income generation and food production are obviously important, but sustainability is critical. The approach is long term and participatory in nature.

## **4.2 Participatory Rural Appraisal of Lower Ing Basin**

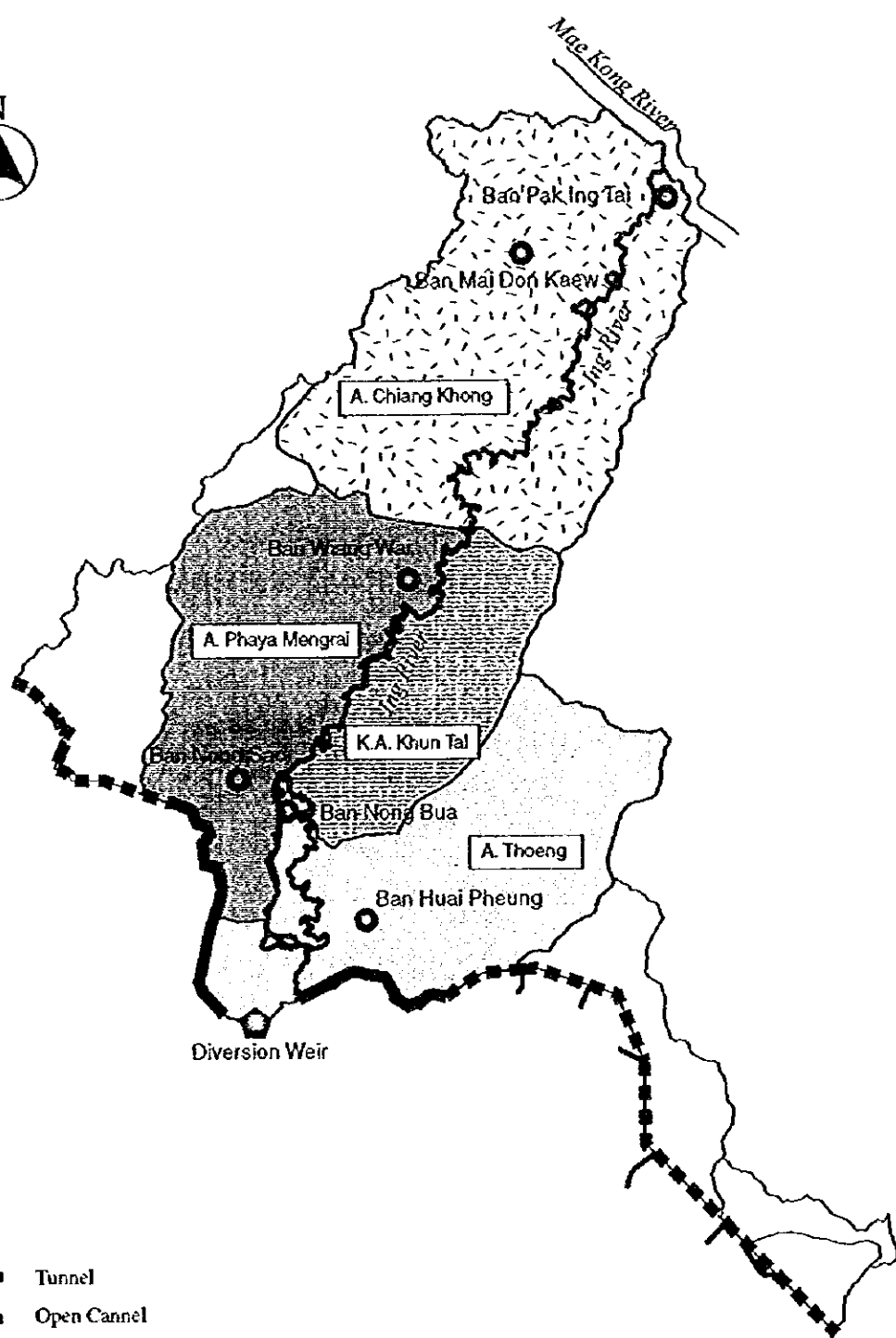
**(1) Objective of the Study**

The aim of this study was to determine the present socio-economic conditions of the villages in the Lower Ing Basin and to identify the people's needs, as well as factors impeding development, which will be reflected in the future participatory and sustainable rural development projects in the area.

Conventional "top-down" approaches to the design of rural development projects have often failed to bring sustainable development of rural communities. A centralised decision-making process had previously left the rural communities without any role to play in the formulation of such projects. Such past experiences, and a realisation that people's participation is fundamental in project planning, are reflected in the Thai Government emphasis on people's participation in decision-making processes under the new constitution. The application of PRA in this study aims to present, from the initial stage of investigation and planning, an alternative approach of formulating a sustainable rural development project, which is based on the needs of the people, and managed and controlled by the local communities.

## **(2) Methodology**

The study area covered the area downstream of the proposed Ing diversion weir in the Lower Ing Basin. After a preliminary site survey of 11 villages, 6 villages were selected for the interview survey, and of which three villages were selected also for PRA session. The locations of the villages surveyed are shown in Figure 4.1.



Legend:

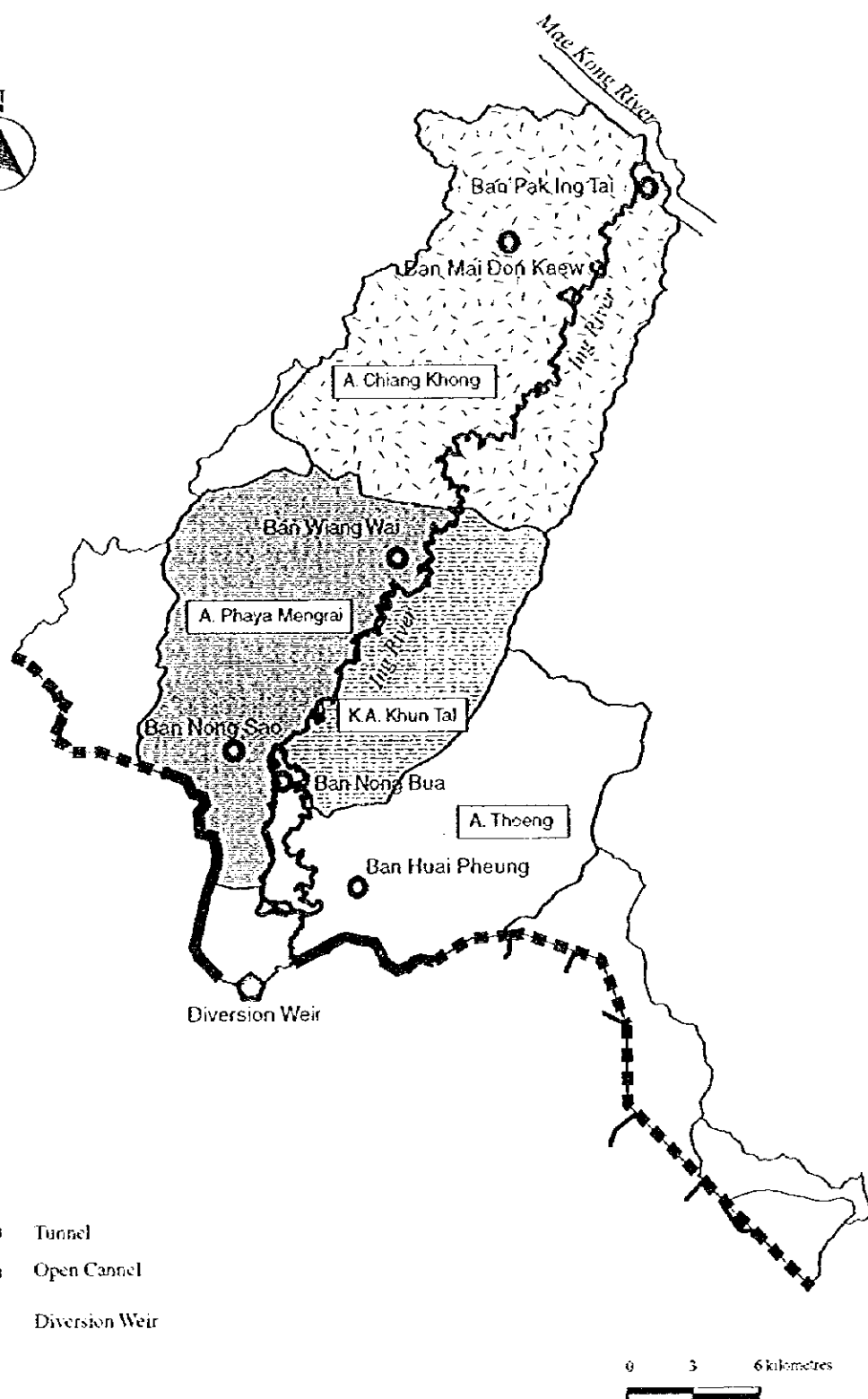
- ■ ■ ■ ■ Tunnel
- Open Cannel
- ⬡ Diversion Weir

0 3 6 kilometres

ENVIRONMENTAL STUDY  
THE KOK-ING-NAN WATER DIVERSION PROJECT  
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 4.1. Location of Surveyed Villages





Legend:

- ■ ■ ■ ■ Tunnel
- Open Cannel
- ⬠ Diversion Weir

0 3 6 kilometres

ENVIRONMENTAL STUDY  
THE KOK-ING-NAN WATER DIVERSION PROJECT  
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 4.1. Location of Surveyed Villages

The following four data collection instruments were developed to identify the present socio-economic conditions of each village and the villagers' intentions for rural development:

- Secondary data: Village Document (Khor Chor Chor 2 Khor, 1996) from the Department of Community Development, Ministry of Interior;
- Village Profile: general information on the village gathered by the research team through a site survey and key informant interviews;
- Interview Survey of the sampled households based on a structured questionnaire format; and
- Participatory Rural Appraisal (PRA).

### (3) Interview Survey

To ensure smooth communications with the villagers in northern Thai dialect, 10 students at Chiang Rai Rachabat Institute, were recruited as enumerators. Prior to the survey, the enumerators underwent orientation and training sessions on the Project, the study objectives, the interview techniques and data recording methods.

In selecting respondents, a village map indicating the location of each household was obtained. From the map, households were randomly selected using sub-sections of the village. Approximately 30 % of the number of households in each village was taken as the basis for determining the sample size. Altogether 274 respondents were interviewed.

#### (a) Living Conditions

The average household size was 4.4. The overall sex ratio of the household members was 50.2 % males and 49.8 % females. With regard to age, 23.5 % of the household members were under the age of 15, 36.9 % were between the age of 16 and 35 years old, 29.5 % between 36 and 60 years old and the remaining 10.1 % were over the age of 60. 177 households (64.6 %) were nuclear families. About 10 % of the household members live temporarily (more than 3 months) outside the community to have a job, mainly during the dry season.

603 household members (49.8 %) were farmers, 177 (14.6%) had other jobs than farming, 109 (9.0 %) had no job and one person was a pension receiver. 321 members (26.5 %) were students or the children under the school age.

For 59.1 % of the households, the main source of income came from the sale of agricultural products. Rice was the main product to sell in all the villages except Pak Ing Tai where selling maize brought the major income for 42.6 % of the households.

For drinking water, many households utilise more than one source. 46.7 % of the respondents make use of the village water supply system, 43.4 % use rain water, 18.6 % water from shallow wells and 12.0 % from deep wells. 15 respondents stated that they buy bottled water. For electricity, all 274 respondent households are supplied with electricity.

The most common possessions of the surveyed households are: a television set (95.6 %), an electric fan (93.8 %), a refrigerator (75.2 %), a tape recorder (72.6 %), an electric iron (70.8 %), and a radio (40.9 %). For vehicles, over two-thirds of the respondent households (67.2 %) have a motorcycle (including a tricycle, which is widely used in Thailand), 59.1 % have a bicycle, 16.8 % have a car (mainly a pick-up type) and only 3 respondent households (1.1 %) have a truck.

The common sources of protein were pork (92.7 %), fish (88.3 %), eggs (86.5 %), chicken (85.0 %), beef (69.3 %) and buffalo (64.6 %). A small number of respondents also

stated duck, snake, frog, rat, snail and crab as protein sources. 86.1 % of the respondents eat one of the above protein sources daily.

In all the surveyed villages the custom of reciprocal help (helping each other in certain occasions without an exchange of money) is practised. The common occasions for this custom are at the time of rice harvesting (62.4 %), a temple fair (16.4 %) and a house building (11.7 %).

All the surveyed villages suffer from both droughts and flooding, respectively 73.0 % and 62.4 % of the respondents stated their occurrence, and these were the two most problematic natural disasters stated by the respondents.

#### (b) Agriculture

36 households (13.1 %) owned no land at all and 100 households (36.5 %) owned no farmland. The number of households without own farmland was particularly high in Huai Pheung (55.9 %) and Pak Ing Tai (42.6 %). The average land owned per household was 9.5 rai and the average land owned and rented was 10.7 rai.

In the rainy season 196 households grow paddy, 100 households grow maize, 57 vegetables, 12 groundnuts, 5 upland rice, 2 soya or black beans and 1 household tobacco. The average planted area for paddy was 12.6 rai per household, for maize 7.1 rai per household and for vegetables 1.8 rai per household. There are 55 households who have an orchard and their average planted area was 5.4 rai per household. Very little farming is practised in the dry season. No sample households grow paddy or upland rice in the dry season.

36 households (13.1 %) raise cows. In Huai Pheung, more than half of the respondents (64.7 %) have a small number of cows, while in Mai Don Kaew none of the respondents raise cows. 2 households in Wiang Wai keep buffaloes. Altogether 12 households raise pigs. Poultry are more popular and 231 households (84.3 %) keep some chickens and 23 households some ducks. 19.0 % of the respondents are engaged in aquaculture.

Major agricultural constraints were: lack of irrigation water (62.4 %); lack of funds (51.1 %); damage by insects (48.2 %); plant disease (44.9 %); and lack of farm land (34.7 %). A lack of irrigation water was the most severe problem stated in all the sample villages, except Wiang Wai.

In regard to the marketing of farm products, 69.3 % of the respondents usually rely on a middleman while 9.5 % market directly. 47.1 % of the respondents expressed their dissatisfaction over the selling price.

56.6 % of respondents make use of rural credit systems. The most popular credit source was BAAC. Of 155 credit users, the average amount of credit was 50,866 Baht and the main use of credit was for farming.

78.1 % of the respondents stated that they would like to cultivate crops during the dry season if enough water were available. Their preferred crops were vegetables and fruit trees.

#### (c) People's Needs and Perception of Community Development

An irrigation project was the most desired project in all the sample villages. In total 164 respondents (59.9 %) stated that an irrigation project would benefit the community.

37.6 % of the respondents knew about the Kok-Ing-Nan Project and the main sources of information were: conversations with neighbours and relatives and TV or radio programmes. Concerning the impact of the project in the area, 13.5 % of the respondents stated that certainly there would be impacts, 26.3 % maybe some impacts, 42.3 % no impact and the remaining 17.9 % either did not answer the question or stated uncertainty.

#### (4) PRA

The main focus of the session was to let villagers formulate a basic plan for future development of the village by identifying the past situation of the village, then comparing it with their current situation and desired, or future, situation.

The two main techniques used during the PRA sessions were focus group discussions and transects. The research team spent two-half days in each village, starting with a focus group discussion with 20-30 representatives of the villagers. Such techniques as mapping, drawing, listing, scoring and ranking were used during the focus group discussions in order to gather information, to identify problems and to prioritise the issues. For example, in Wiang Wai, one of the three villages where PRA was conducted, the following village map was drawn during a focus group discussion. The group also made a list of problems they were currently facing and prioritised them by scoring each problem with grains. A series of transects (walking through the village with villagers) was also conducted to gather more information through observation and informal conversations with the villagers.

Figure 4.2 PRA: Wiang Wai Village Map (drawn by a female group)

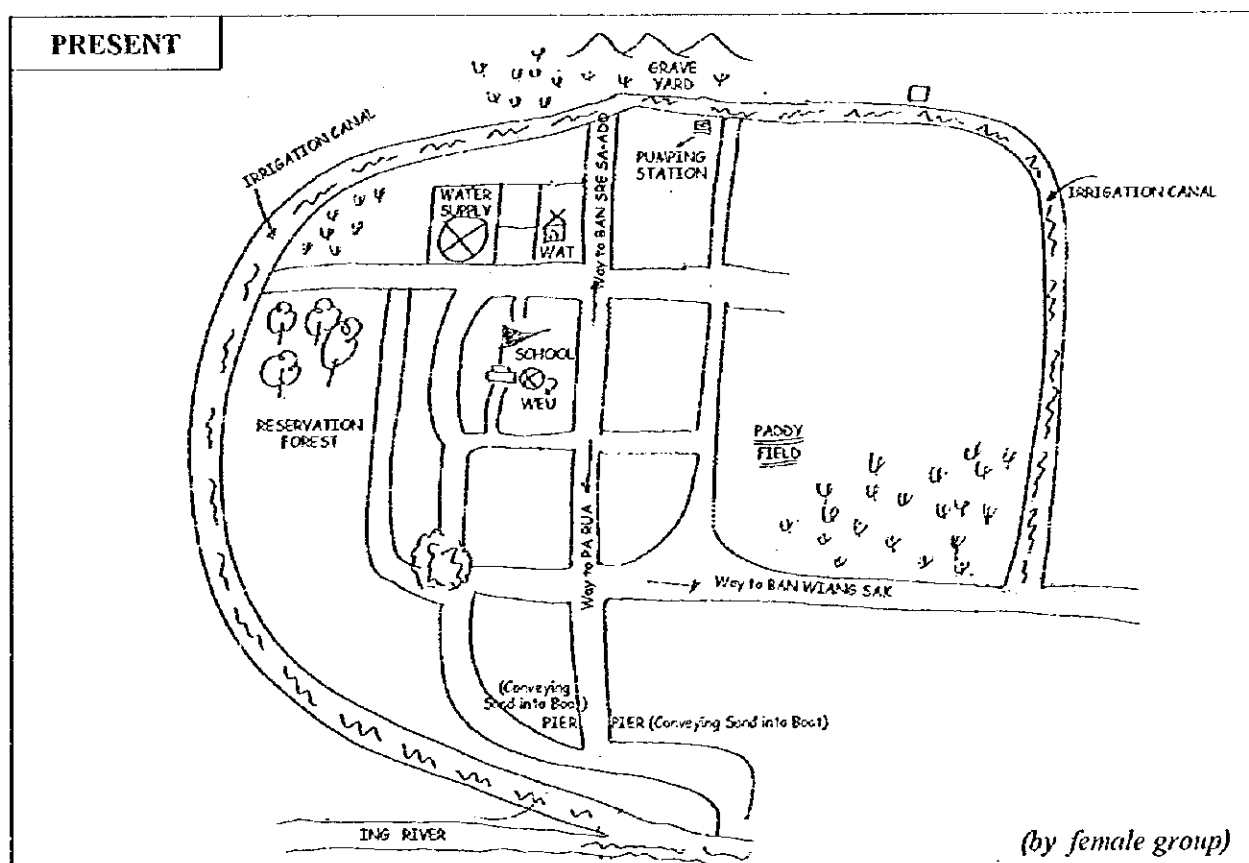


Figure 4.3 PRA: Wiang Wai Drawing a Map



Figure 4.4 PRA: Wiang Wai Scoring Problems

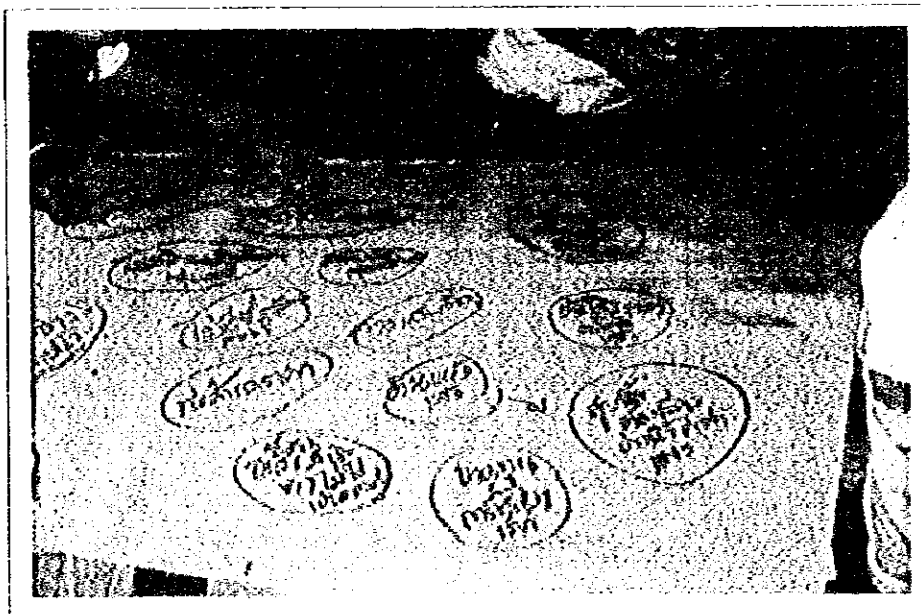


Figure 4.5 PRA: Wiang Wai Problem List

#### EXISTING PROBLEMS

1. Drought / Lack of water in the dry season
2. Low price of maize
3. No paved road
4. Not enough income
5. Middleman determines low prices for agricultural products
6. No weir across the river
7. No public telephone
8. No work after harvesting
9. No vocational training
10. Infertile soil
11. No bus service
12. Drug addiction
13. No support group for women
14. No money for children's education
15. High cost of electricity for pumping water (dry season)

PRA sessions conducted in the three sample villages should be seen as case studies, as each village has its own unique history and social and economic conditions. PRA was applied to present an alternative approach of community development, in which the local people are recognized as the main actors in their development process. PRA is a method of promoting people's participation and indigenous knowledge in the process of community development. It is necessary to accelerate sustainable rural development in the donor basins prior to the Kok-Ing-Nan Project. In this context, wider application of PRA in donor basin communities will benefit for the formulation of sustainable rural development projects.

#### (5) Recommendations for Sustainable Rural Development

The findings from the survey, especially from the PRA sessions, indicate some priority areas for future rural development. Though each village has its own priority and suitable ways of realisation, the following common areas were found important for the future development of communities in the donor basin:

- **Water Resource and Irrigation Development**  
Most of the villages have a severe problem of water shortages in the dry season. In some villages even the supply of drinking water poses a problem in the dry season. The provision of safe drinking water throughout the year needs to be addressed urgently. Very little farming is currently practised in this area during the dry season due to the lack of water. Even in the villages relatively close to the Ing River, water cannot be supplied due to the low water level. The plan formulation and execution of small-scale irrigation projects, which assure the supply of irrigation water to the farmers in the dry season, would be vital to improvement of the socio-economic conditions of the area.
- **Agricultural Diversification**  
In order to achieve sustainable agricultural development, agro-forestry and integrated farming and aquaculture should be further promoted. In the surveyed villages it was found that some farmers are currently engaged in agricultural diversification including dairy farms, aquaculture, together with poultry or animal husbandry, orchards, etc. For such a diversification process, farmers need an initial investment as well as a means of supporting themselves until any benefit

accrues (especially fruit trees, aquaculture and animal husbandry). Provision of credit services or a farmers' support fund, for instance, from the proposed Donor Basin Sustainable Development Fund (DBSDF) will benefit farmers.

- **Improving Quality of Life**  
Social problems such as drug addiction, out-migration of youths, AIDS, etc. were pointed out during the survey. Such social problems are often the result of depressed economic conditions and limited employment opportunities in the area. The introduction of agro-industry and promotion of cottage industries using locally available resources will provide employment opportunities for the villagers, especially after the rice harvest season. Measures to support farmers, women and youths by providing facilities and amenities should be considered in order to improve their quality of life.
- **Conservation and Rehabilitation of Natural Resources**  
In all the surveyed villages, the degradation of community forest is serious. Due to increased population and expansion of farmland, forests have been reduced and degraded severely in recent decades. In most cases villagers are aware of the consequences of forest destruction. At present most villages have a forest management committee which exercises some degree of forest management. Further promotion of forest conservation and rehabilitation, with an emphasis on community forestry will support sustainable development of the area.
- **Upgrading Rural Infrastructure**  
During the PRA session when comparing life in the past and present, the villagers noted significant improvements made to the infrastructure and facilities in and around the village. However, further improvement of infrastructure was discussed by the villagers, including rural water supply systems, construction of irrigation canals, construction of dikes for flood protection, road improvement, etc.

#### 4.3 People's Irrigation Systems

*Muang Fai*, or People's Irrigation System (PIS), is the traditional gravity-fed irrigation system often found in the northern region of Thailand. PIS, known to have existed for hundreds of years, is developed communally by groups of farmers. This system has proved successful and efficient in management of water resources due to its long period of use and fair distribution of water at farm-level. Each group has a *Kae Fai* (weir chief) or *Kae Muang* (canal chief), who is a respected and knowledgeable member of the community, selected by the group members to act as the leader. Each group has a set of effective laws and regulations known as *Sanya Muang Fai*, in which members' duties and responsibilities are clearly stated and which are agreed upon among the water user members.

During the previous study stage, several PIS groups were identified in the area where the Kok-Ing diversion canal is proposed. Simultaneously, it was recognised that construction of the diversion canal could cause significant negative impacts on the existing PIS unless suitable mitigation measures are taken. Impacts on the farmers whose land is directly affected and who need compensation have been already assessed by the TEAM/JV. However, the impacts on those PIS groups were not studied. A more detailed survey on the existing PIS groups was, therefore, included in this study stage.

The objectives of the study are to identify existing PIS groups along the Kok-Ing diversion canal, to analyse the impacts of the Project, and to propose mitigation measures.

##### (1) Existing PIS and Problems

Fourteen PIS groups were identified along the Kok-Ing canal route. The identified PIS groups vary considerably in size, both in terms of cultivated land and the number of member households. For example, Pracha Asa Weir Group in Tambon Mai Ya has only 12 households as members and its

cultivated land is 100 rai whereas Chai Sombat Weir Right Bank Group consists of around 2200 households from 15 villages and the area of cultivated land is 15,000 rai.

Most of the farmers in the 14 groups are engaged in small-scale, rain-fed rice cultivation in the rainy season. The irrigation water of most of the PIS groups is applied almost exclusively during the rainy season in order to supplement the rain. In general, very little farming is practised in the dry season due to the shortage of water. Ten groups cultivated less than 10% of their wet-season farmland during the dry season. Twelve out of fourteen groups mentioned shortage of water in the dry season as a severe problem. Five of them noted shortages of water even in the rainy season. Water shortages in the rainy season may last one to four weeks between June and September and are due to rainfall variations during the rainy season. Water demand is highest in July for rice cultivation in these areas. Water shortage during this period is mainly due to competitive water use of farmers (land soaking water). Five groups (of which four are in the Kok Basin and one in the Ing Basin) mentioned flooding in the rainy season as one of their problems.

Out of the fourteen PIS groups identified, six are in the Kok Basin and eight are in the Ing Basin. Water supply sources of the PIS groups found in the Kok Basin are from rivers: i.e. Mae Korn, Mae Lao and Mae Sa Kuen, all of which are tributaries of the Kok River. Those in the Ing Basin are usually from constructed reservoirs on natural streams. Among the PIS groups studied, Thun Khan Chai Group in the Ing Basin is the only group using the pumping irrigation system. Although most of the surveyed PIS groups suffer from a shortage of water in the dry season, the PIS groups in the Ing Basin suffer more severely from the water shortage, even in the rainy season, due to the limited storage capacity of reservoirs.

Most of the groups have a committee, which organises member meetings and an annual day, or days, for repair and cleaning of the canals. About half of the groups collect a "Water Fee" (in reality it is more like a membership fee) from each member, according to the size of his/her farm, while some groups collect a voluntary donation when necessary. Some groups also demand a penalty in the case of a member being absent from repair, cleaning or meetings.

With respect to the groups' organisation, the Chai Sombat Weir Right Bank Group in the Kok Basin represents the most organised and self-reliant PIS group. As mentioned above, this group is the largest, consisting of 2200 member households from 15 villages, but it is well managed by the committee under the leadership of an energetic Kae Fai (Weir Chief). The committee members gather monthly and try to solve the problems they are facing. On the other hand, there are a number of less mature groups, which were recently formed due to an external influence, i.e. the intervention of government agencies in irrigation development. For example, Mai Ya Group was formed by the encouragement of ARD after the agency had constructed Huai Mai Ya Reservoir and main canals in 1985. Similarly, Huai Khun Plong Reservoir Group was established in 1984 on the recommendation of RID.

Although a shortage of water is found to be the most serious problem for the PIS groups surveyed, there are other factors which impede the development and which need to be addressed. The following are the problems most often expressed by the farmers during the discussions:

- Shortage of water in the dry season, or even in the rainy season in some cases;
- Low price of farm products, which is often determined by a middleman;
- High cost of farm inputs such as fertiliser, pesticide and herbicide;
- Lack of suitable marketing outlets or lack of marketing knowledge;
- Lack of adequate agricultural credit; and
- Shortage or high cost of farm labour.



## (2) Impacts and Mitigation Measures

The expected impacts of the Project on the PIS groups are classified into physical and social aspects. In relation to the physical barrier created by the construction of the diversion canal, a PIS group will be divided into the "head" and the "tail" sections of the group as shown in Figure 4.2.

Typical impacts expected by the PIS groups are periodical flooding in the head section, shortage of water in the tail section and the subsequent social segregation of the group.

The mitigation measures such as construction of drainage system, siphons or overshoots, bridges, have to be considered in order to minimise the negative impacts on the existing PIS groups.

## (3) Remarks and Recommendations

Most of the PIS groups along the Kok-Ing diversion canal suffer from water shortages in the dry season. Those groups which enjoy irrigation water from the weir at Chai Sombat located in the Lao river, a tributary of the Kok river, have encountered significant water shortage due to the development of the upper Lao river (123,000 Rai at Lao weir, and others). Therefore, the Chiang Rai weir constructed by DEDP is intended to supply the water to the area of Chai Sombat on behalf of the Lao weir. It is estimated that there is still "surplus water" amounting to more than the planned water of 2,000 MCM to be diverted in the rainy season, even taking into account water requirement under such assumption that the maximum development be executed in the donor basins of Kok and Ing rivers. However, it will be indispensable to reach mutual consensus among the representatives of the stakeholders through public consultation with the people in the donor basins, the subjects of which are a future plan to provide the people in the area concerned with sufficient water all year round and whether such "surplus water" be recognized to be diverted to another basin. In addition, the detail of the diverted water shall be well informed to the public, from the viewpoint of public disclosure.

Many farmers along the Kok-Ing diversion canal will lose substantial areas of their farmland due to the construction of the canal. Fair compensation for the land as well as the appropriate method and the timing of payment should be addressed and agreed. Further, in order to compensate for the loss of land, which is the most important factor in agricultural production, it is recommended that the government should try to assist the farmers in the area in improving their agricultural practices. For example, implementation of small-scale irrigation projects to secure year-round water supply to the farmland, agricultural extension works on crop diversification and integrated farming and the introduction of small-scale agro-industry will all help promote sustainable agricultural development, and will also improve the life of the farmers in the area.

It is inevitable for any social structure to undergo change as a result of the socio-economic evolution of the society. The PIS is of no exception and the system is already undergoing some changes due to such factors as the introduction of modern farming and irrigation facilities, urbanisation of the community, a shift from subsistence farming to commercial farming, migration of young people to the city, etc.. Recent government interventions have also influenced the structure of PIS groups to a certain extent. However, the PIS has functioned efficiently as a small-scale, self-reliant irrigation system for hundreds of years in the northern region and it still plays a significant role in farming communities. It is, therefore, important that the main principles of organisation and management system should be respected and supported when mitigation measures are planned and implemented. Some of the groups have expressed their willingness to co-operate, if the project is approved by the government, provided fair compensation and all the necessary mitigation measures are arranged. They also expect to benefit from the project by receiving additional irrigation water to their irrigation systems.

Considering the time lag between the current study stage and the implementation of the Project, it is predictable that the PIS in the area will change according to the social and economic evolution of

the area. Small PIS groups in proximity of Amphoc Muang and Wiang Chai might be eliminated by urbanisation in the next two decades. New irrigation projects such as DEDP Chiang Rai Weir Irrigation Project will also alter the current organisation of PIS groups in the area. It is therefore necessary to study the conditions of the PIS groups and re-assess the impacts on the groups at a later stage.

